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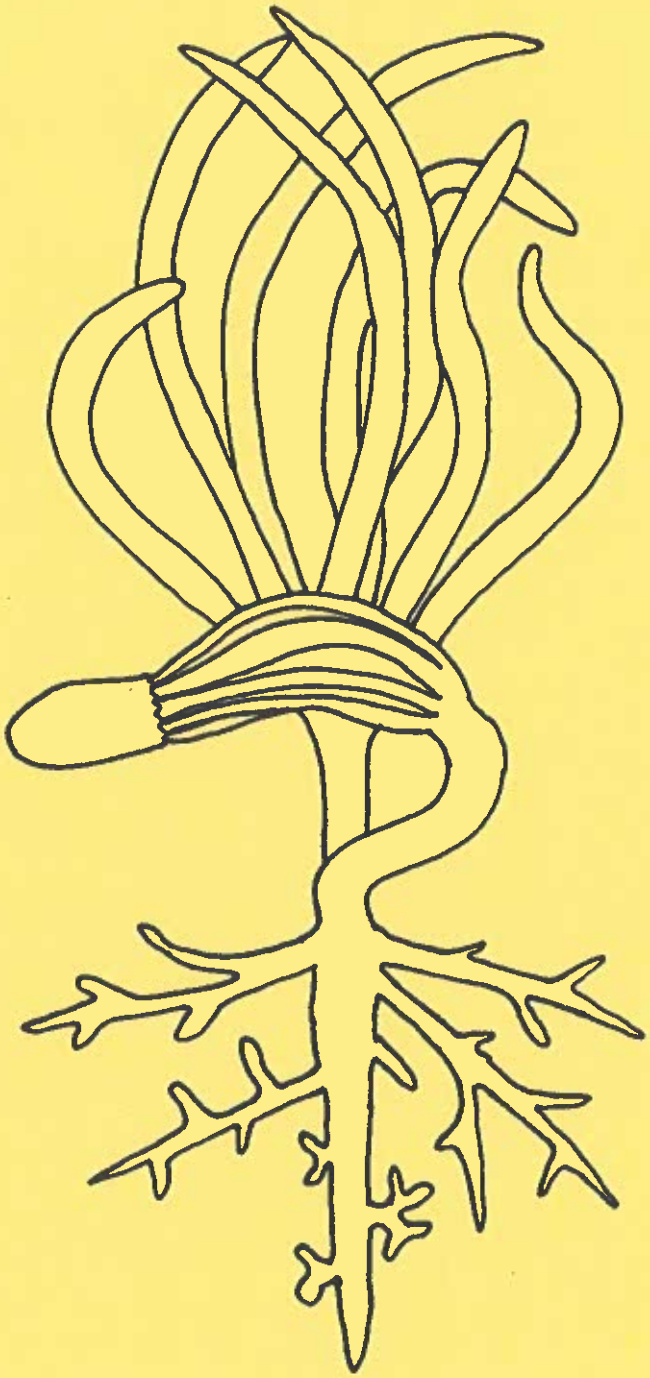

22nd PLANT DEVELOPMENT WORKSHOP

Saturday, November 5, 1988

Department of Botany, University of Toronto

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University of Toronto

PROGRAM

9:00 Registration and coffee - Room 207C

9:30 Presentations - Room 7

9:30 CHRISTINE KAMPNY, Department of Botany, University of Toronto and Royal Ontario Museum. Floral development in Veroniceae and Rhinantheae (Scrophulariaceae)

9:45 JEAN M. GERRATH and USHER POSLUSZNY, Department of Botany, University of Toronto and Department of Botany, University of Guelph. Floral development in *Leea guineensis*.

10:00 PAMELA DIGGLE, Department of Botany, University of Toronto. Sex expression in the andromonoecious species *Solanum hirtum*: floral morphogenesis and sex determination.

10:15 TOKUSHIRO TAKASO, Harvard Forest, Harvard University. Cone ontogeny in *Cryptomeria* (Taxodiaceae)

10:30 Coffee Break - Room 207C

11:00 D. DALES and R.I. GREYSON, Department of Plant Sciences, University of Western Ontario. Phenotypic characteristics of the maize mutant "male sterile silky (ms-si)".

11:15 PAMELA JACOBS and R.L. PETERSON, Department of Botany, University of Guelph. Altered fungal morphogenesis during early stages of ectomycorrhiza formation in *Eucalyptus pilularis*.

11:30 HILARY NIELD and JOHN N.A. LOTT, Department of Biology, McMaster University. Distribution of minerals within different regions of *Cucurbita maxima* fruit.

11:45 JOHN N.A. LOTT, PATRICE KERR, THELMA LEECH, HILARY NIELD and IRENE OCKENDEN, Department of Biology, McMaster University. The influence of experimentally induced changes in the (Ca + Mg)/K balance upon protein bodies in developing *Cucurbita* seeds.

12:00 Lunch - Room 207C
Posters - Room 203

CHRISTIAN LACROIX and USHER POSLUSZNY, Department of Botany, University of Guelph. Phyllotactic patterns in some members of the Vitaceae.

CAROL L. WENZEL and M.E. MCCULLY, Department of Biology, Carleton University. Do cortical cells of corn roots senesce during normal development?

T.P. WILSON, M.J. CANNY and M.E. McCULLY, Department of Biology, Carleton University. Proton pump activity in bundle sheath tissues of broad-leaved trees in relation to leaf age.

1:30 Presentations - Room 7

1:30 EWA MELLEROWICZ, Department of Biology, University of New Brunswick. The influence of temperature and photoperiod on dormancy and frost hardiness in the cambium of Abies balsamea.

1:45 JANUSZ J. ZWIAZEK and TERRY J. BLAKE, Faculty of Forestry, University of Toronto. Physiological responses of black spruce to repeated drought stress.

2:00 NASSERULLA, S. and K. WINTERHALDER, Department of Biology, Laurentian University. Effects of sodium chloride concentrations on growth of bermudagrass (Cynodon) from saline and non-saline habitats in Australia.

2:15 JANE P. YOUNG, Department of Botany, University of Toronto. Leaf phenotypic plasticity in Ranunculus flabellaris: the effect of abscisic acid.

2:30 NANCY G. DENGLER, CAROL E. RITLAND and PETRA M. DONNELLY, Department of Botany, University of Toronto. Leaf development and vascular organization in Anisophyllea disticha.

2:45 Coffee Break - Room 207C

3:00 Invited speaker:

P.B. TOMLINSON, Harvard Forest, Harvard University. Unique features of shoot developmental morphology in Phyllocladus (Podocarpaceae).

4:00 Reception - Room 207C

ABSTRACTS

DALES, D. and R.I. GREYSON. Department of Plant Sciences, The University of Western Ontario, London, Ontario N6A 5B7 - Phenotypic characteristics of the maize mutant "male sterile silky (ms-si)".

The male sterile silky (ms-si) is a recessive genic mutant that is tightly linked, on the long arm of chromosome 6, to the endosperm colour (yl) locus. With selected crosses the recessive white endosperm colour allele has been linked to the recessive ms-si allele. Using this marker enables the selection of white seeds as homozygous male sterile-silky for use in experimental studies. This genic floral mutant can thus be used to study the mechanisms, stages, enzymes and nutrients involved with floral development and sexual differentiation of the ear and tassel associated with the maize plant. Attempts at chemical reversion of male sterility for potential use in hybrid seed production is another aspect of study.

Morphologically, ms-si is distinguished by a variable range of stamen and kernel development.

Tassel:
1) aberration of stamen development
2) a silk-like structure, in some instances, which emerges from the spikelet and is associated with the connective tissue of the aberrant stamen

Ear:
1) 2 to 3 times more silk than the wild type
2) 2 or 3 subsidiary structures, associated with each gynoecium, called "supernumerary ovaries" from which a silk emerges
3) abortion of supernumerary ovaries such that mature kernels do not develop but the silks remain attached and are not easily removed from the mature ear

DENGLER, NANCY G.*, CAROL E. RITLAND and PETRA M. DONNELLY. Department of Botany, University of Toronto, Toronto, Ontario, Canada M5S 1A1 - Leaf development and vascular organization in Anisophyllea disticha.

Anisophyllea disticha is a small tropical tree characterized by Massart's architectural model: orthotropic shoots with helically-arranged scale leaves produce tiers of plagiotropic shoots at the end of each growth flush. Plagiotropic shoots are anisophyllous and bear dorsal scale and ventral foliage leaves arranged in a unique tetrastichous system. In this study we compare leaf development in the two types of shoots and the relationship between leaf development and the pattern of primary vascular differentiation. In orthotropic shoots leaf expansion is related to the cycle of rhythmic growth, and leaf tissues mature precociously. A single leaf trace enters the leaf base in the third plastochron, and vascular tissue differentiation continues throughout leaf expansion. In plagiotropic shoots, expansion of scale and foliage leaves is of similar duration, but occurs at different rates. Foliage leaves are characterized by extended plate meristem activity, while scale leaf tissue matures early. Dorsal scale leaves and ventral foliage leaves differ in the number of leaf traces, the timing of procambial strand extension into the leaf base and the pattern of vascular differentiation. These observations demonstrate the strong correlation among shoot symmetry, leaf development and vascular differentiation within dimorphic shoots of one species.

DIGGLE, PAMELA K. Department of Botany, University of California, Berkeley, CA 94720 - Sex expression in the andromonoecious Solanum hutum: floral morphogenesis and sex determination.

Recent hypotheses for the evolution and maintenance of andromonoecy have suggested it provides a mechanism to adjust fruit set to available resources without limiting male reproduction. This hypothesis predicts that sex expression is labile and that floral sex may be determined late in development. Completion of gynoecial development (and ultimate floral sex) would depend on resources available for subsequent successful fruit maturation. This hypothesis is evaluated by an investigation of floral development in the andromonoecious Solanum hutum. Individual plants may produce both hermaphrodite and staminate flowers. At anthesis, staminate flowers are recognized by their reduced gynoecia: staminate mean ovary length is 1.6 mm and mean style length is 3.6 mm compared with hermaphrodite mean ovary length of 2.6 mm and style length of 11.5 mm. The ovaries of staminate flowers bear reduced ovules that contain nonfunctional embryo sacs. SEM and measurements of dissected buds show that development of the two floral types is qualitatively and quantitatively similar from inception to a bud length of 4-5 mm (1/4-1/3 of final bud dimensions). Subsequently, the rate of gynoecium development in staminate flowers relative to hermaphrodite flowers decreases, resulting in a reduced gynoecium at anthesis. Experimental evidence indicates that this reduction in rate is reversible and buds less than 9 mm may be induced to develop into hermaphrodite flowers. These results support the suggestion that development and sex expression in Solanum hutum is labile.

GERRATH, JEAN M.* and USHER POSLUSZNY. Department of Botany, University of Guelph, Guelph, Ontario N1G 2W1 - Floral development in Leea guineensis G. Don.

The family Leeaceae is separated from the Vitaceae on the basis of its mature floral features. The Vitaceae possess a floral "disk" and two ovules per locule, whereas the Leeaceae have one ovule per locule and lack such a "disk". Instead they possess what is interpreted to be a staminodial tube. Recently we have undertaken what is apparently the first floral developmental study of a member of the Leeaceae, using both epi-illumination light microscopy and scanning electron microscopy. The results of this study will be presented and compared to our previous studies of floral development in the Vitaceae. Results indicate that the differences in mature flower structure are largely the result of differences in degree of development, not pattern of development.

JACOBS, P.F., R.L. PETERSON and H.B. MASSICOTTE. Department of Botany, University of Guelph, Guelph, Ontario N1G 2W1 - Altered fungal morphogenesis during early stages of ectomycorrhiza formation in Eucalyptus pilularis.

Scanning electron microscopy (SEM) of Eucalyptus pilularis roots inoculated with Pisolithus tinctorius revealed altered morphogenesis of fungal hyphae in contact with the root surface. These changes occurred prior to the formation of a full fungal mantle and resulted in the formation of a compact fungal layer as a consequence of fusion of proliferating, branching hyphae. Although similar growth patterns have been observed in the inner mantle of fully developed ectomycorrhizae using contrast interference microscopy, this is the first time this feature has been demonstrated during early mantle formation using SEM. Changes in fungal morphology during early stages of colonization may be correlated with recognition between the symbionts, and the subsequent establishment of a symbiotic relationship between compatible partners.

KAMPNY, CHRISTINE M. Department of Botany, University of Guelph, Guelph, Ontario, Canada N1G 2W1 - Floral development in Veroniceae and Rhinantheae (Scrophulariaceae).

Distinctive patterns of floral development were observed in members of the Veroniceae and Rhinantheae with respect to number of floral parts, their position, and their relative growth rates. In the Veroniceae, the floral organs were initiated centripetally on a domed apex, commencing with the abaxial sepal primordia. The asymmetric calyx enlarged and covered the inner series. Among these, the two stamens grew fastest, the gynoecium more slowly. The corolla primordia did not enlarge much until the stamens showed well differentiated thecae, but then the corolla grew to soon surpass the anthers, and finally also the calyx lobes. The developmental pattern in the Veroniceae was similar to that of the Rhinantheae, which also showed a domed floral apex, and a delay of growth in the perianth, especially the corolla. However, floral development in the Rhinantheae differed from that in the Veroniceae in that the gynoecium remained the tallest organ through much of organogenesis. Also, the four stamens were located laterally and abaxially from the large gynoecium. Both these developmental patterns were strikingly different from those observed in the Agalineae and Antirrhineae. They supply further evidence for the value of floral developmental patterns as systematic characters, and for the importance of heterochronic changes as sources of variation in floral form.

LACROIX, CHRISTIAN*, and USHER POSLUSZNY. Department of Botany, University of Guelph, Guelph, Ontario, Canada N1G 2W1 - Phyllotactic patterns in some members of the Vitaceae.

Three phyllotactic patterns were observed in individuals of Vitis riparia, cv. Vanessa and cv. Vivant. In each of these representatives two decussate (opposite) cotyledons were visible in the young seedlings, followed by leaves arranged in a 2/5 phyllotactic spiral, followed by leaves arranged in a complex repeating pattern with tendrils opposite the leaves at two out of three nodes. The transition from spiral to distichous phyllotaxy seems to occur upon initiation of the first tendril. The pattern of leaf and tendril initiation that follows also shows some interesting positional relationships between the shoot and the organs. Although the tendril is initiated directly opposite a leaf (approx. 180° divergence) it appears to be shifted to one side of the shoot in the following plastochrons, making the shoot asymmetrical in cross-section. A morphological study of the developing shoot of a seedling at these different stages in its growth shows some differences between the apical meristem and the organs that are successively initiated from it. Transition in patterns are also looked at from the point of view of existing phyllotactic theories and their powers of explanation.

LOTT, JOHN N.A.*, PATRICE KERR, THELMA LEECH, HILARY NIELD and IRENE OCKENDEN. Department of Biology, McMaster University, Hamilton, Ontario, Canada L8S 4K1 - The influence of experimentally induced changes in the (Ca+Mg)/K balance upon protein bodies formed in developing Cucurbita seeds.

Seeds store mineral nutrients required for growth of the seedling plants. The main mineral storage compound, which is called phytate, is stored inside protein bodies. In some cases the phytate is uniformly distributed through the proteinaceous matrix but in many cases it is concentrated into dense bodies called globoid crystals. Indications are that the (Ca+Mg)/K balance may be important in controlling globoid crystal formation (Lott et al., 1985, Aust. J. Plant Physiol. 12, 341-353). To test this hypothesis further developing Cucurbita fruits were injected with KCl and other salts. Squash embryos generally have large globoid crystals and a relatively high (Ca+Mg)/K ratio. We hypothesized that if we could reduce the (Ca+Mg)/K ratio we would also alter the size and number of globoid crystals. Developing fruits were remarkably tolerant to injection of sterile salt solutions over time periods of several weeks but the developing embryos were remarkably resistant to our attempts to alter the minerals taken up for storage. The elemental content of embryo tissues was measured quantitatively with neutron activation analysis. Controls plus those few samples showing a distinct shift in the (Ca+Mg)/K ratio were analyzed further. Energy dispersive x-ray analysis of cryogenically prepared samples was used to study the elemental content of protein bodies and transmission electron microscopy was used to study the ultrastructure of the protein bodies.

MELLEROWICZ, EWA. Department of Biology, University of New Brunswick, Bag Service #45111, Fredericton, New Brunswick E3B 6E1 - The influence of temperature and photoperiod on dormancy and frost hardiness in the cambium of Abies balsamea.

In the fall, the development of frost hardiness in the cambium of Abies balsamea occurs simultaneously with the transition between the dormancy stages of rest and quiescence. To separate the two phenomena, 6-year old plants, in the resting stage, were subject to either 20°C (W) or 5°C (C) temperatures combined with either 8 hr days and night light interruption (L) or 8 hr days (S) for two months. Frost hardiness of the cambium was determined as the survival rate after freezing to -40°C, measured by staining for succinic dehydrogenase activity. Frost hardiness developed under all conditions, the least under WL, significantly more under WS, and the most under CL, CS, and outdoor control (O). Dormancy stage was assessed by monitoring the ability of the cambium to respond to exogenous IAA. Rest graded to quiescence under all conditions as all trees responded to exogenous IAA. The response was least under WS, more under WL and O, and the most under CS and CL. Thus, under warm temperatures, the long days promote progression through dormancy stages but decrease the development of frost hardiness. However, the treatments also influenced the differentiation of cells formed in response to IAA. Warm temperatures decreased lignification and increased phloem production (70%) as compared to cold or outdoor conditions (40%).

NASSERULLA, S and K. WINTERHALDER. Department of Biology, Laurentian University, Sudbury, Ontario P3E 2C6 - Effects of sodium chloride concentrations on growth of bermudagrass (Cynodon) from saline and non-saline habitats in Australia.

Ten samples of bermudagrass (Cynodon dactylon (L.) Pers.) collected from populations in saline and non-saline habitats in Australia, were glasshouse cultured. Clones were sand cultured, with levels of sodium chloride varying from 0%-4% in the nutrient solution, and their growth indicators measured. All clones showed salt tolerance but differed in their response to increasing salt concentration; growth of all decreased significantly at higher salinity.

NIELD, H and J.N.A. LOTT. Department of Biology, McMaster University, Hamilton, Ontario, Canada L8S 4K1 - Distribution of minerals within different regions of Cucurbita maxima fruits.

Pericarp, embryo and testae of mature squash fruits were analysed to determine whether or not 1) the fruits' orientation to the ground had any influence on the concentration of minerals 2) different regions of the pericarp had an uneven distribution of minerals 3) there is a relationship between mineral concentrations of seeds and nearby pericarp. Mg, K, Ca and P concentrations were measured by neutron activation analysis. Pericarp samples, taken from the stalk region or stigma region or placental region, were further divided into rind, middle, innermost and stringy or fuzzy samples. Seeds were separated into embryo, outer and inner testae samples. Results showed that the fruit orientation did not influence concentration of minerals in the samples. The stigma and stalk regions differed in Ca and K concentrations in middle and innermost samples. Placenta mineral concentrations did not differ from the other regions. K and Ca were more concentrated in pericarp than in embryo samples whereas P and Mg had the opposite relationship.

TOMLINSON, P.B. Harvard Forest, Harvard University, Petersham, MA 01366, U.S.A. Unique features of shoot developmental morphology in Phyllocladus (Podocarpaceae).

Phyllocladus is a genus of 4 species distributed in S.E. Asia and Australasia. It develops flattened branch complexes (phylloclades) that resemble compound leaves, unique within the Coniferales. They have been homologized with shoot complexes in Devonian Archaeopteris. Architectural analysis shows a precise developmental pattern that admits of little opportunistic modification. Phylloclades are either determinate or indeterminate, the latter forming the architectural framework of the tree; all are initiated within the expanding terminal bud at the start of each growth cycle, expand sylleptically and develop up to three branch orders. The distal axes show distichous phyllotaxis (possibly unique for conifers) and strong planation associated with extensive adnation, but there is no disruption of a normal leaf-branch association. Cones are developed within the same cycle and are unusual in that ovules are borne directly in cone-scale axils. The architecture of the tree may be analyzed simply in terms of meristem distribution and potential; indeterminate meristems function only once in phylloclade expression. The analysis demonstrates that comparative morphology may have little meaning in the absence of extensive developmental analysis.

WENZEL, C.L. and M.E. MCCULLY. Department of Biology, Carleton University, Ottawa, Canada K1S 5B6 - Do cortical cells of corn roots senesce during normal development?

There are numerous reports that cortical cells senesce in otherwise healthy roots of cereals, including corn (e.g. Deacon et al. 1986 Ann. Bot. 58, 719-). These conclusions have been based on the apparent absence of nuclei in transverse sections stained with the DNA-binding fluorochrome, acridine orange. Senescence is said to progress from the outer to the innermost cortical layers at increasing distance from the root tip.

We have studied roots from seedlings and mature roots of corn on both transverse and longitudinal sections. The latter showed nuclei in all cortical cells with no indication of senescence. Cells of different layers in the cortex elongate to different lengths, beginning in the outermost layers. Most sections cut through long cells do not include the nuclei. Thus earlier reports that cells are senescing are based on a serious misinterpretation.

Measurements of cell lengths in developing roots show that the degree of cell "senescence" based on the apparent absence of nuclei in transverse sections is a function of section thickness and distance from the root tip.

Studies of wheat and barley roots show the same pattern of cortical cell growth.

WILSON, T.P.*, M.J. CANNY and M.E. MCCULLY. Department of Biology, Carleton University, Ottawa, Canada K1S 5B6 - Proton pump activity in bundle sheath tissues of broad-leaved trees in relation to leaf age.

Extended bundle sheath systems (paraveinal mesophyll), common in legumes, have been found in seven broad-leaf tree species and variation in their proton extrusion pump activity was monitored from May to September within one season. The presence of the extended bundle sheath (EBS) cells was determined using cleared leaves and Nomarski optics. The fluorescent tracer dye, sulphorhodamine G (SR), was used as the probe for active proton extrusion pumps (Canny, M.J. 1987. Pl. Cell and Envir. 10: 271-274). As the dye is transpired into the leaf it is accumulated within cells possessing the proton extrusion pumps. These proton pumps are thought to be used to provide energy for active uptake of amino acids from the transpiration stream. This dye accumulation was easily observed using paradermal hand sections and fluorescence microscopy. All of the trees possessing an EBS system stopped accumulating SR as the season progressed. Total cessation occurred at different times for the different tree species. Failure of the EBS cells to accumulate the dye is thought to coincide with initiation of nutrient export from the leaf before leaf fall.

YOUNG, JANE P.* and NANCY G. DENGLER. Department of Botany, University of Toronto, Toronto, Ontario M5S 1A1 - Leaf phenotypic plasticity in Ranunculus flabellaris: the effect of abscisic acid.

Developmental plasticity is demonstrated in Ranunculus flabellaris Raf., the yellow water crowfoot, by a change in leaf form upon changing environmental conditions. Leaves are broad with few lobes in the terrestrial environment, while, in contrast, highly divided leaves are formed underwater. Submergence in abscisic acid (ABA) solution results in the suppression of the production of underwater leaves, and instead, leaves that are morphologically and anatomically similar to terrestrial leaves are formed. These observations have led to the postulation that ABA plays a role in the environmental control of heterophylly. Quantification of ultrastructural features of epidermal and mesophyll cells, including cell wall and chloroplast characteristics, have provided further evidence for an involvement of ABA in this phenomenon. Critical stages of early leaf development are now being documented to study the timing of divergence of developmental pathways under terrestrial and underwater conditions. Subsequent work will involve the measurement of endogenous ABA levels at these stages. It is expected that these studies will further the understanding of the developmental mechanism(s) resulting in leaf phenotypic plasticity in aquatic plants.

ZWIAZEK, JANUSZ J. and TERENCE J. BLAKE. Faculty of Forestry, University of Toronto, Toronto, Ontario M5S 1A1 - Physiological responses of black spruce to repeated drought stress.

The effects of repeated drought cycles on water relations, photosynthesis, and the composition of soluble carbohydrates and amino acids were studied in ramets of black spruce (Picea mariana Mill.). Plants were grown in solution culture and preconditioned by exposure to increasing concentrations of polyethylene glycol. At higher leaf water potentials, preconditioned plants maintained lower osmotic potentials and higher turgor potentials, but photosynthetic rates were similar in both groups of plants. Preconditioning increased levels of soluble carbohydrates but did not significantly affect total amino acid levels. The conditioning treatment increased stomatal sensitivity to water stress and stomatal conductance was lower in preconditioned plants soon after water stress was imposed. Preconditioned plants maintained significantly lower osmotic potentials during a severe water stress and were able to maintain turgor at the time when unconditioned plants wilted. Severe water stress resulted in increased levels of monosaccharides and certain amino acids in both preconditioned and unconditioned plants. However, preconditioned plants had higher levels of amino acids and lower osmotic potentials than unconditioned plants.